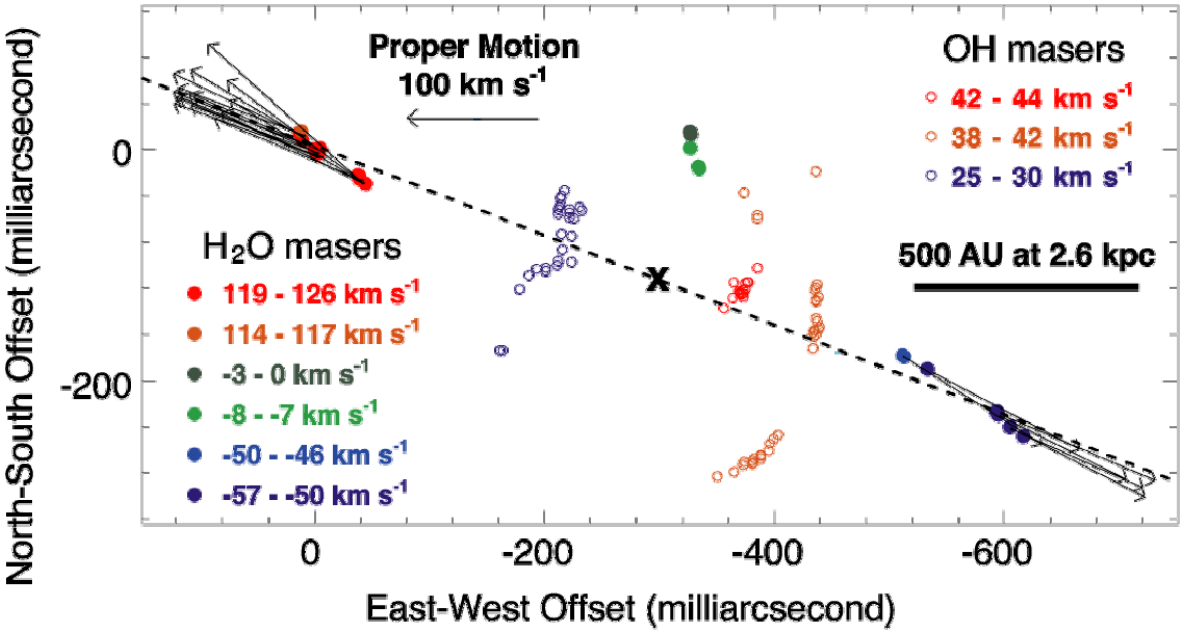
OH maser envelopes of the "water fountain" sources

Hiroshi Imai
Faculty of Science, Kagoshima University

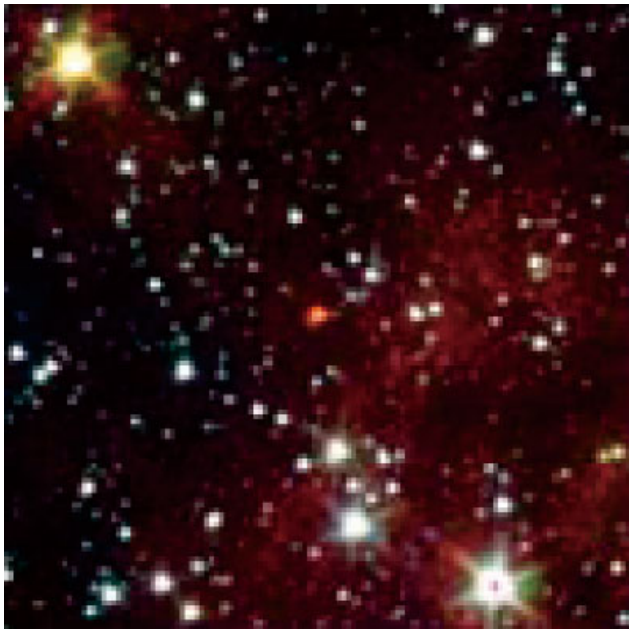
Total Solar Eclipse on 22 July 2009 in Kagoshima

Photo by J. Shukuya

“Water fountains”: collimated fast stellar jets



H_2O/OH masers in W43A (Imai et al. 2002)



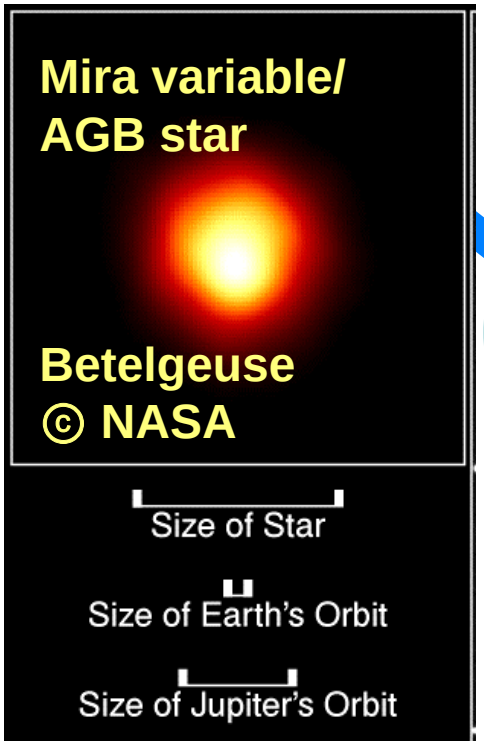
SPITZER/GLIMPSE image around W43A (Deguchi+ 2007)

Very fast (>100 km/s) from AGB/post AGB starts

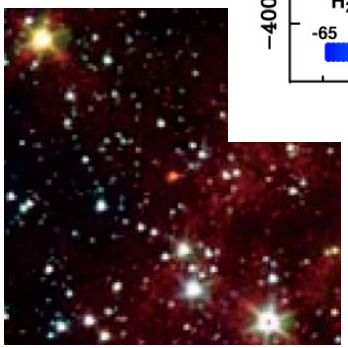
Very young/short lived (<100 years)

Very drastic ($dM/dt>10^{-4}M_{sun}yr^{-1}$)

What is the water fountain precursor?

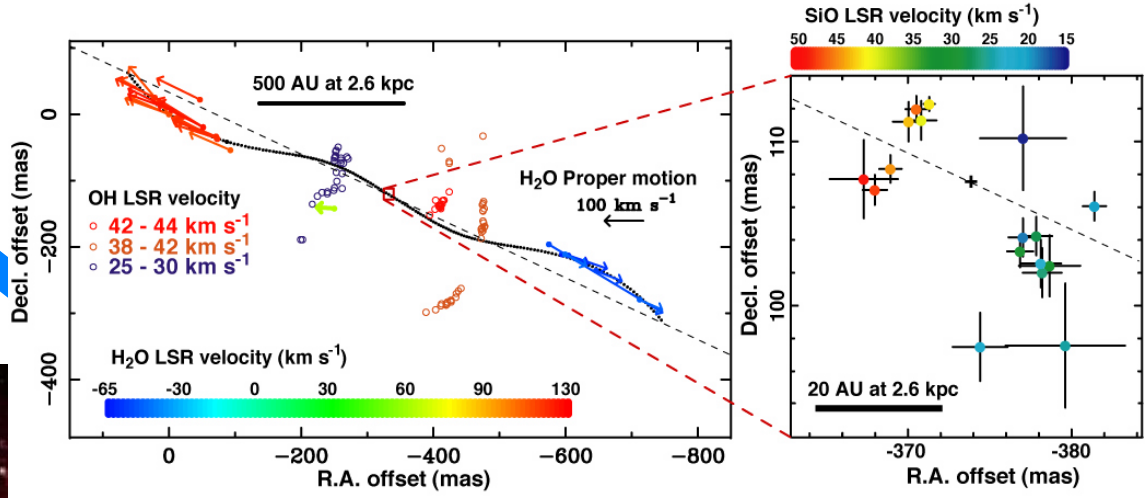


?



Water fountains in AGB or post-AGB phase

e.g. W43A (Imai et al. 2002, 2008)



What happens in the final AGB phase?

The H_2O maser jet and the 1612 MHz OH maser envelope driven by the same stellar object?

EVN/Global VLBI observations of 1612 MHz OH masers

Collaboration with

Phil Diamond (JBCA)

Jun-ichi Nakashima, Sun Kwok (Hong Kong Univ.)

Shuji Deguchi (NRO)

- Toward W43A (1994 June - 2007 June)
  - VLBA (BD03, BD20, BI24), Global VLBI (GI01, GI04)
  - Phase-referencing for astrometry:
    successful in GI04 with J1833+0115=LANA (4.72 deg away)
- Toward IRAS 18286-0959 & 18460-0151 (2007 June)
  - EVN (EI09: Ef,Wb,Jb1,Tr,Cm,On25,Mc,Nt,Hh)
  - Phase-referencing for astrometry with
    - J1832-1035 (for IRAS 18286-0959, 0.67 deg away)
    - J1833+0115=LANA (for IRAS 18460-0151, 4.96 deg away)

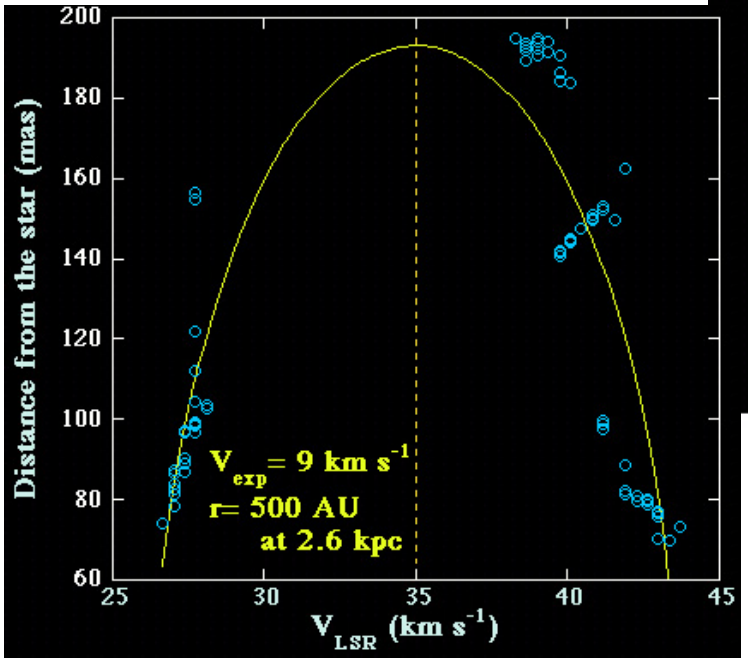
W43A

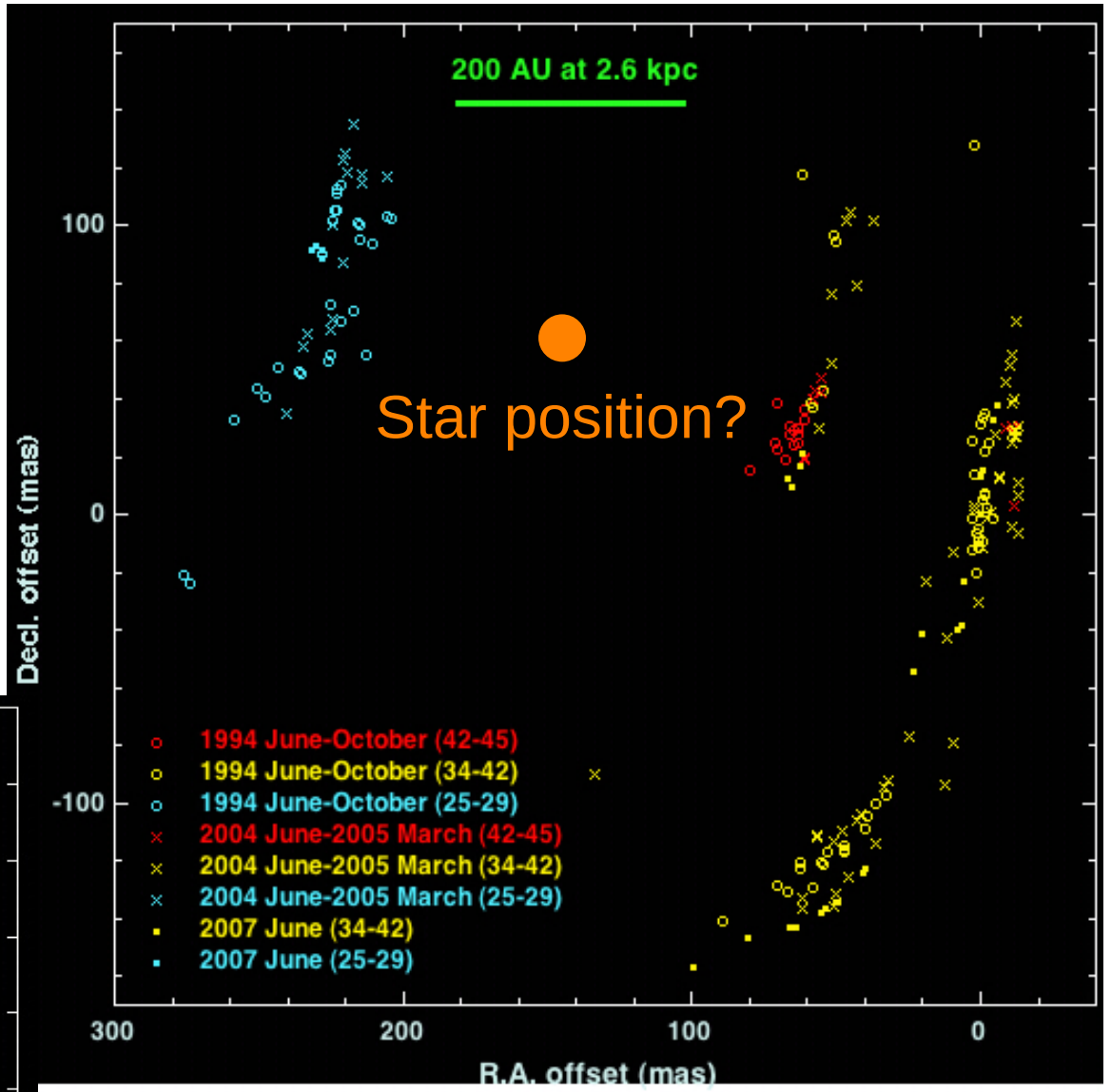
OH masers

Spherical expansion with elongation

~9 km/s in L.O.S

Opposite velocity gradient against H_2O

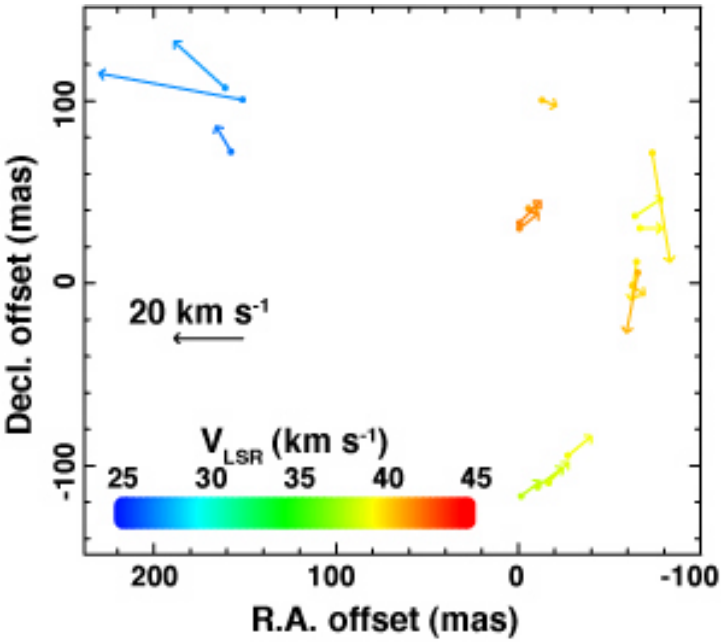




Envelope dynamical age

150—300 years

W43A OH shell expansion



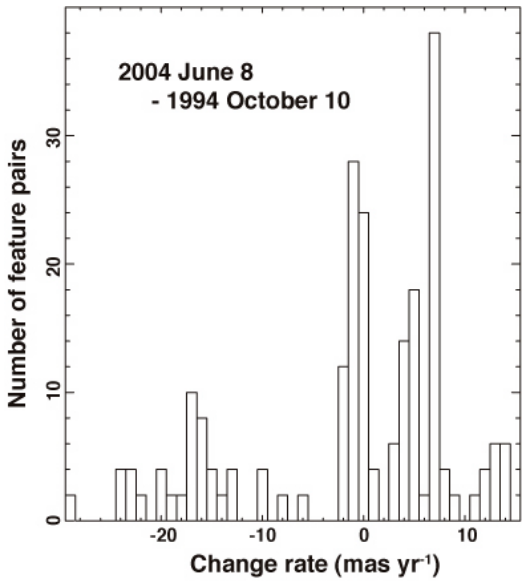
- (a few) feature brightness peak proper motions with expansion
- Feature pair statistics: (marginal) positive expansion

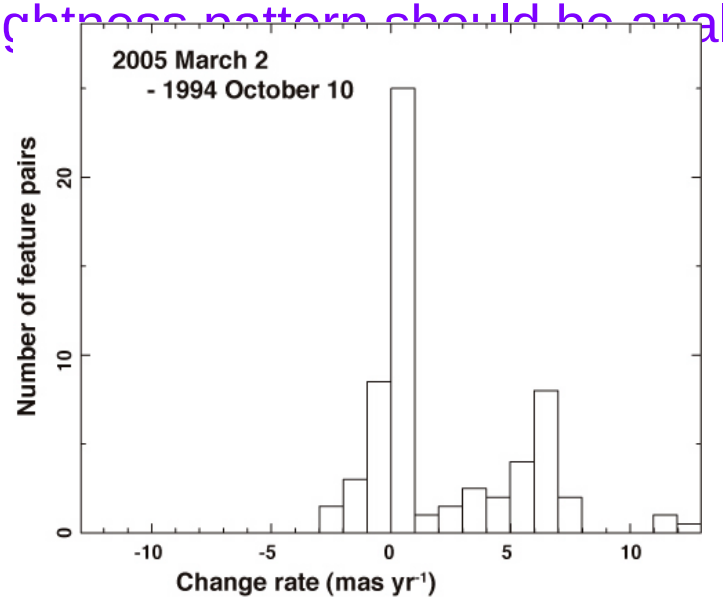
Radial expansion ~20 km s^{-1}

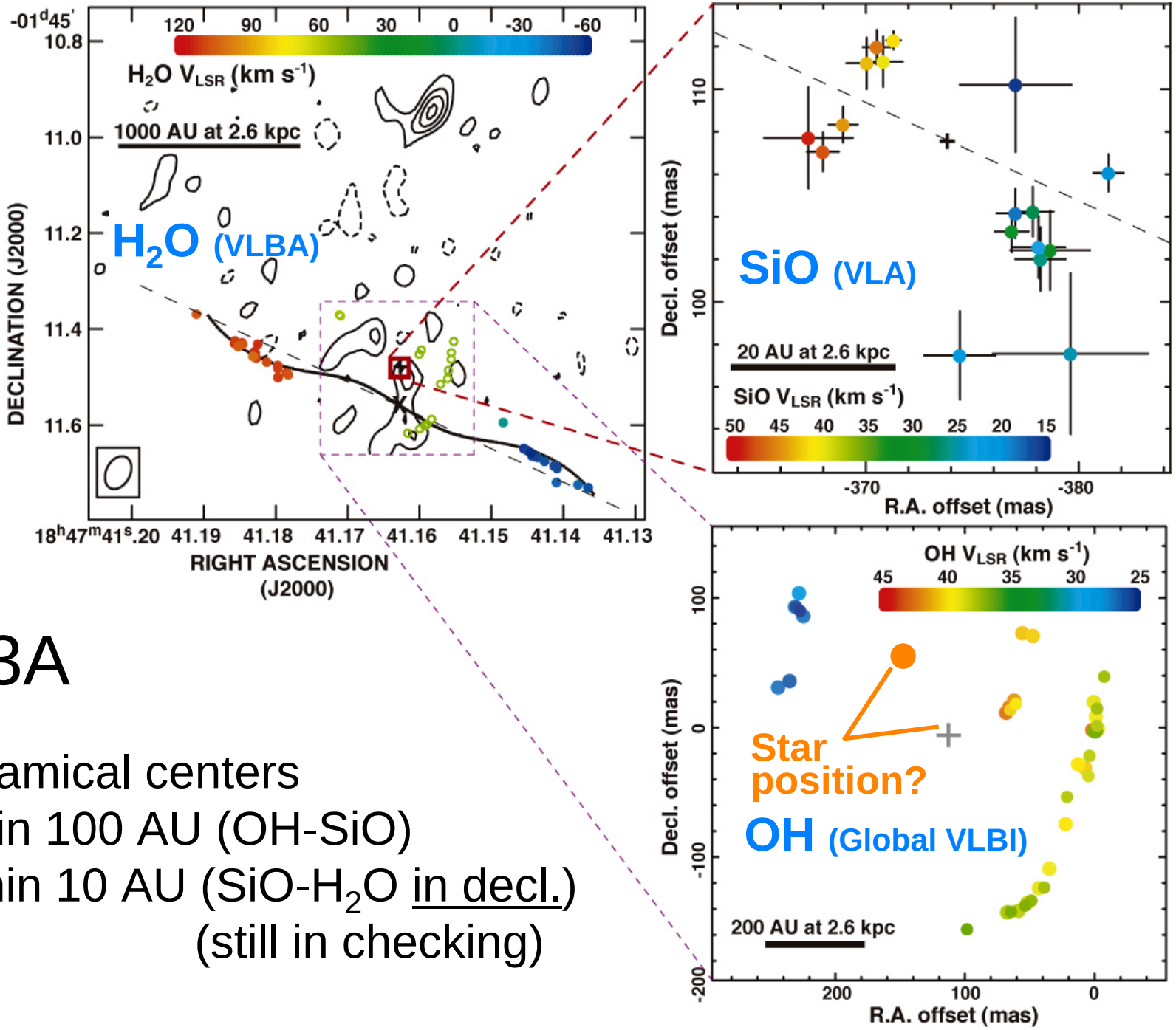
Flow major axis parallel to the H_2O jet

Contaminated by brightness structure variation

Brightness pattern should be analyzed.





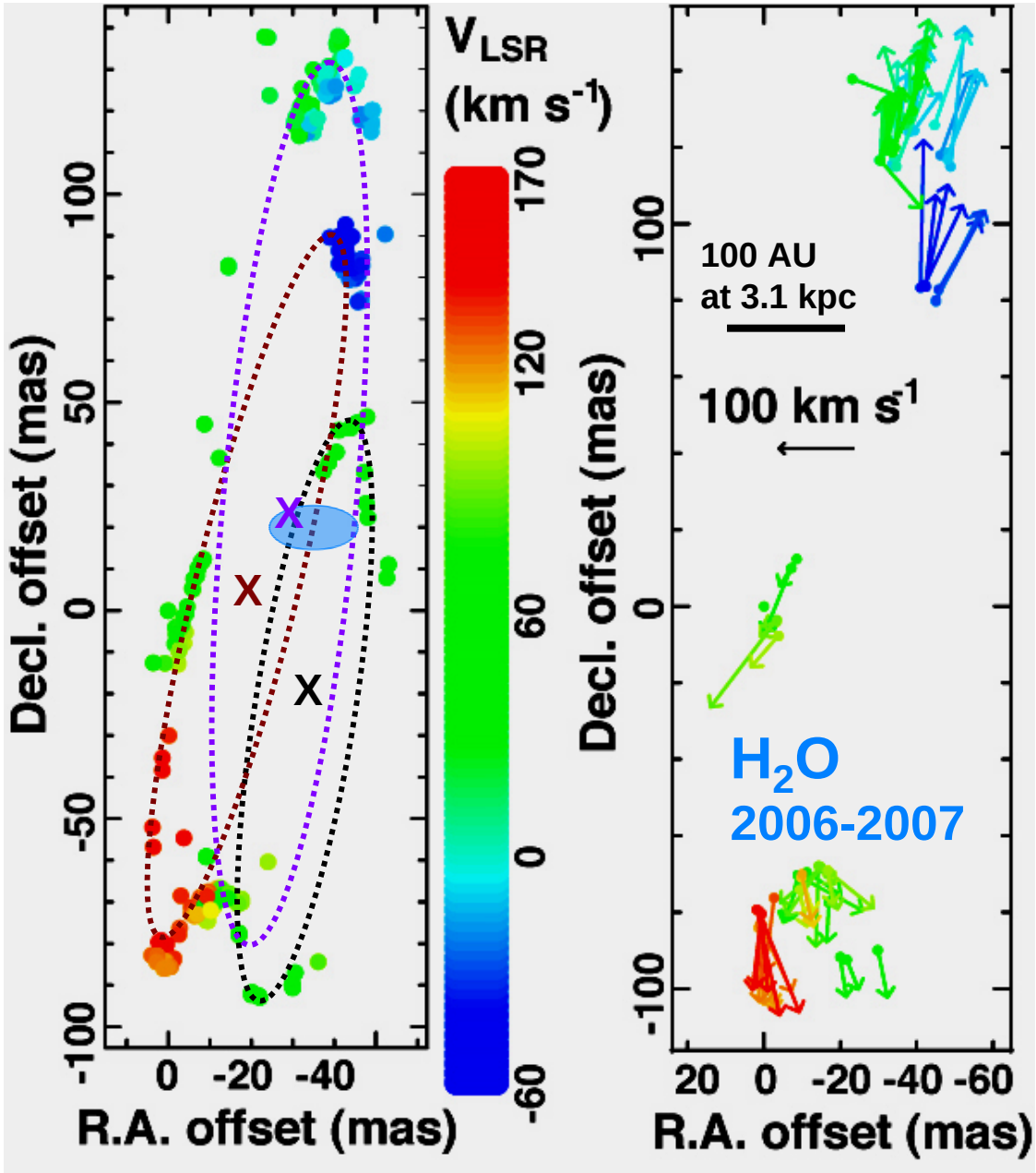


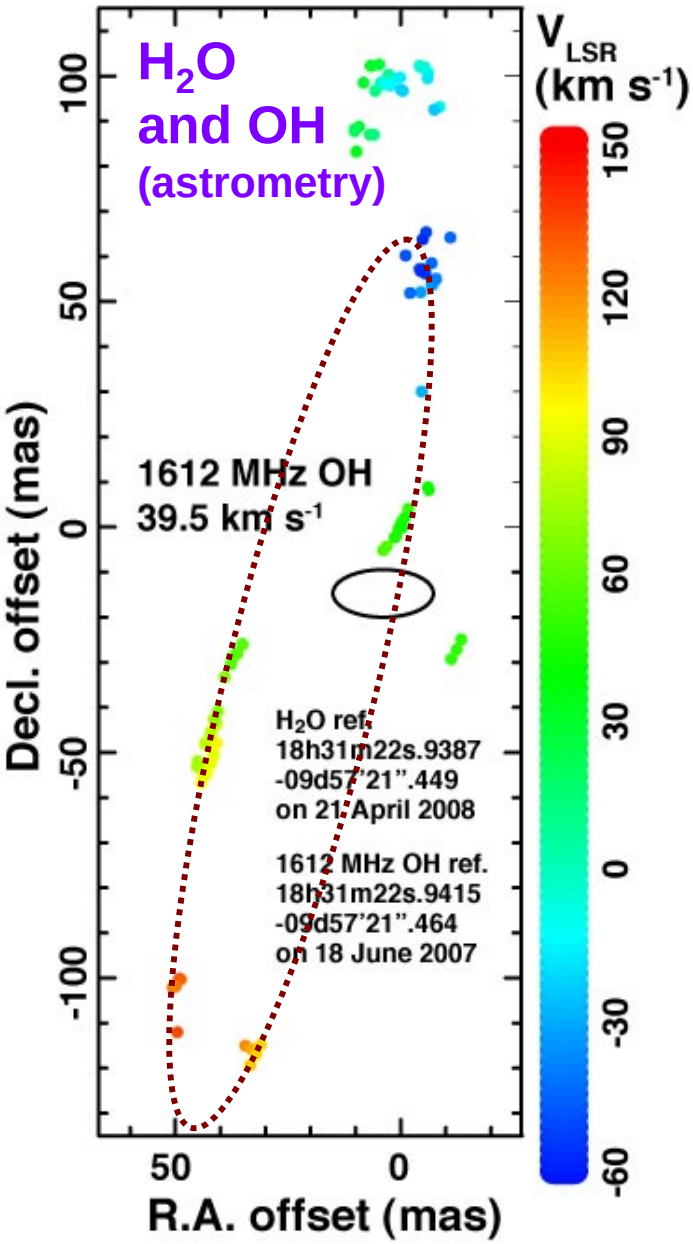
W43A

Dynamical centers
within 100 AU (OH-SiO)
Within 10 AU (SiO-H_2O in decl.)
(still in checking)

IRAS 18286-0959

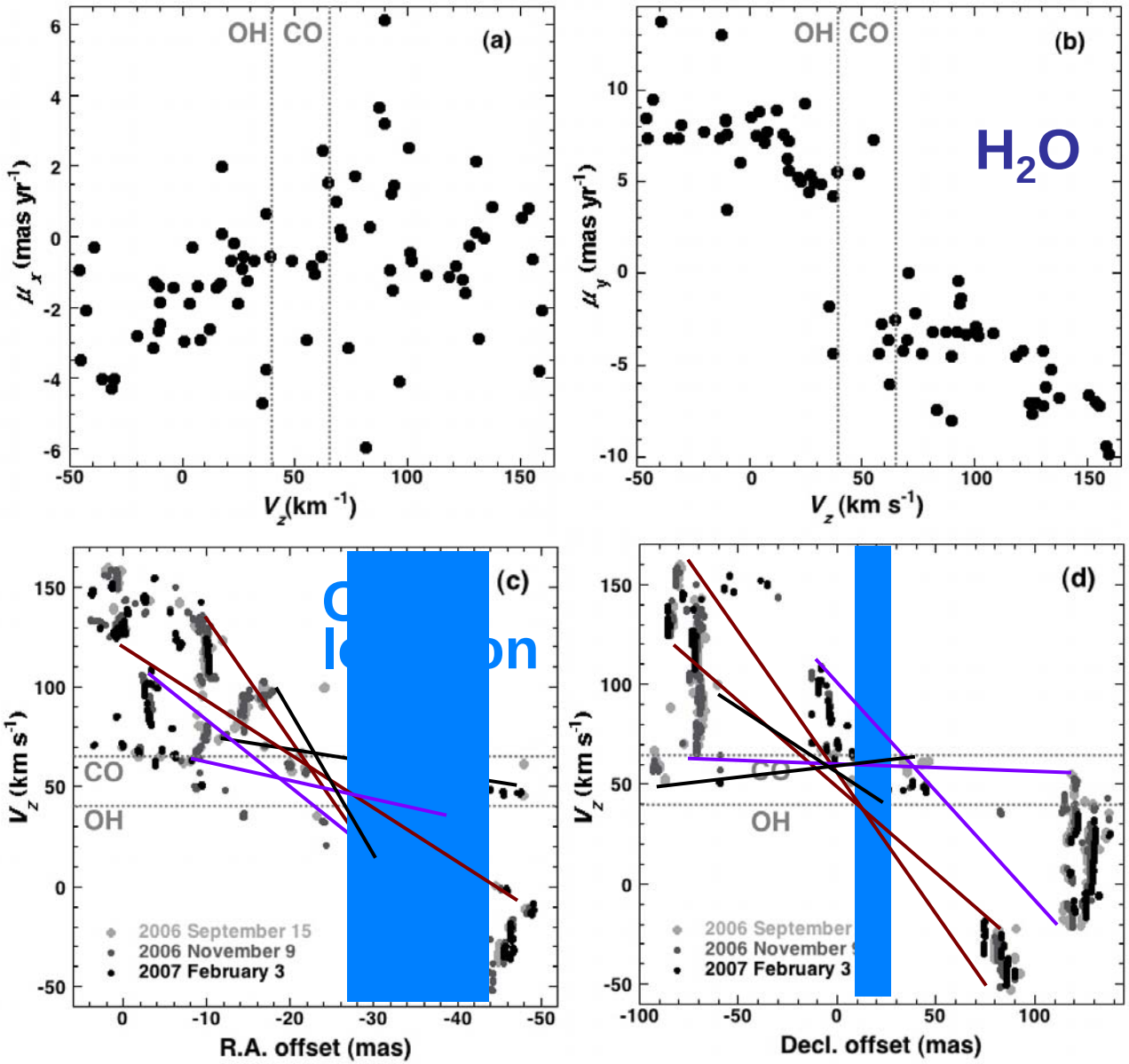
Arcs in 3 elliptical patterns

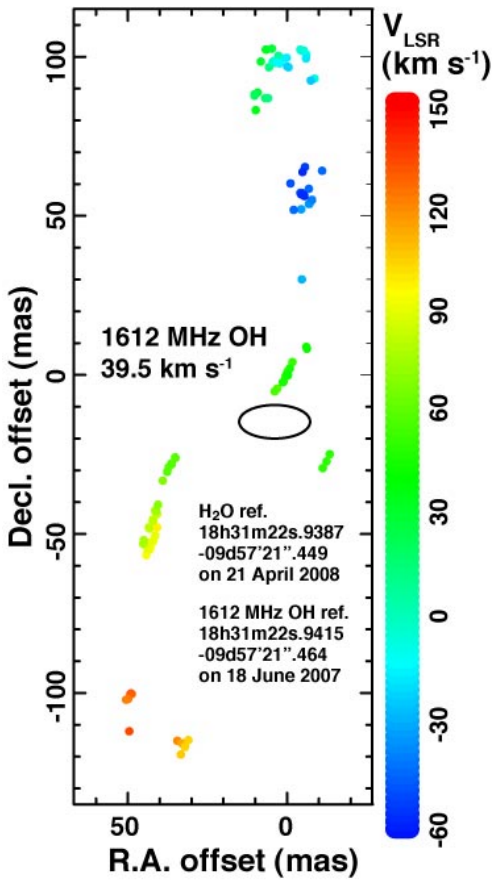




IRAS 18286-0959

Point symmetry
in position and velocity





H_2O/OH
dynamical centers
within **60 AU**

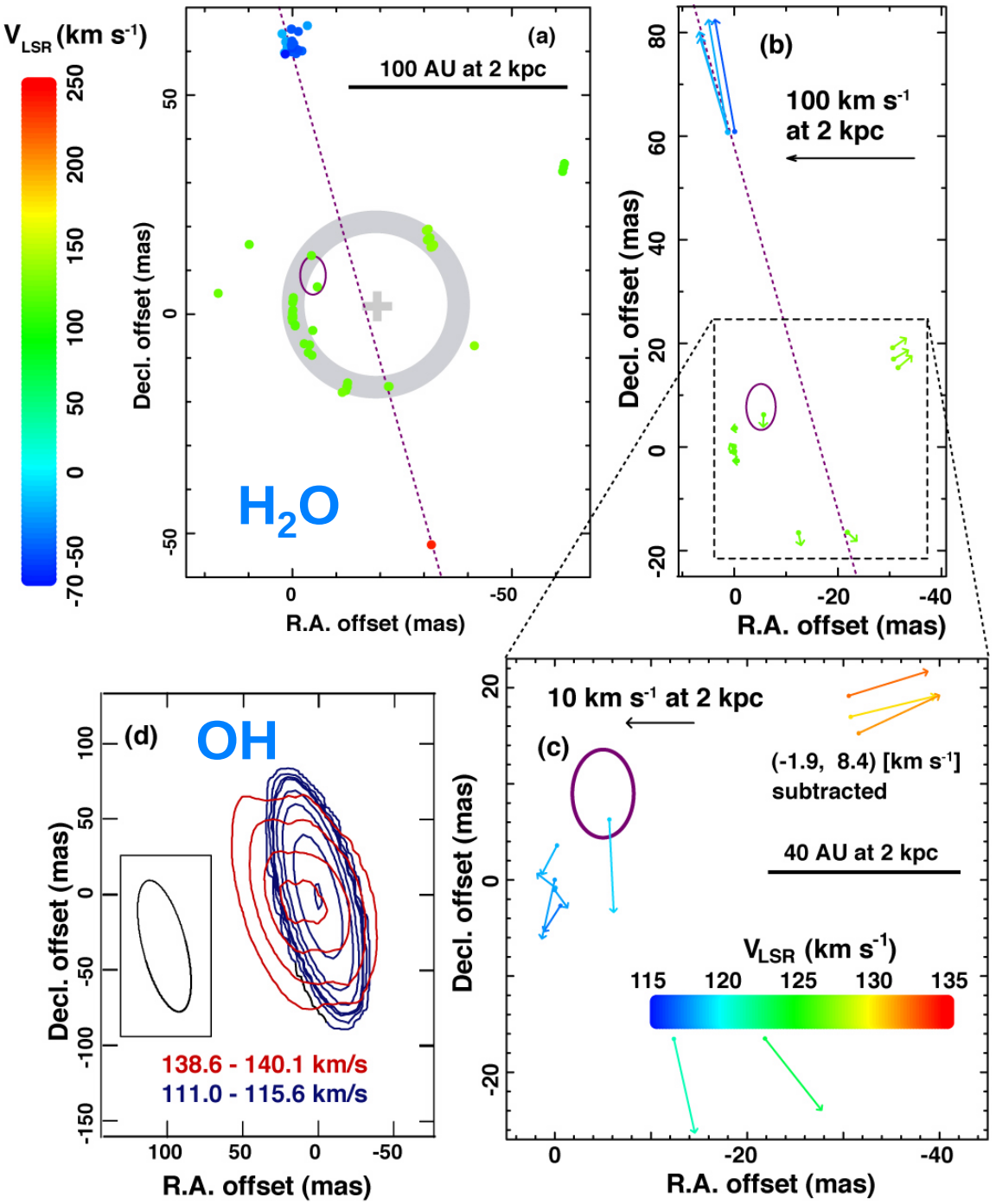
IRAS 18460-0151

High velocity jet (~180 km/s)
+
Equatorial/spherical flow (~15 km/s)

Similar scale and velocity in the H_2O and OH regions opposite velocity gradients

Dynamical centers within 30 AU

Kinematic distance ~6.8 kpc
H_2O model fitting distance **~2 kpc**



Parameters

	V_{jet} (H_2O) [km/s]	$V_{envelope}$ (H_2O/OH) [km/s]	t_{jet} (H_2O) [year]	$t_{envelope}$ (OH) [year]	Separation [AU]
W43A	~150	~30/10	~35	150—300	10—100?
IRAS 18286-0959	~180	~?/15	~15	?	~40?
IRAS 18460-0151	~190	~10/15	~5	>20	~30?

- Co-location of a high-velocity collimated jet and a low-velocity spherical envelop within 100 AU.
- Separation between a high-velocity collimated jet and a low-velocity spherical envelop by > 10 AU?
- Speeds of the OH envelopes/H_2O equatorial flows: ~10—20 km/s ~ V(typical AGB envelope

Simultaneous development of a stellar jet and an envelope/torus

- Common sequence of evolution between PPNe and water fountains
- Time lag ~ **200-300 years**
- Interaction event between a torus followed by a jet on a short time scale
- **Binary system scenario** may produce the interaction event and explain (multiple) discrete mass ejection.
- The interaction event may occur in AGB phase.